

temperatures (e.g., temperatures of intake air, oil, water, etc.) at approximately the same temperature as specified by the manufacturer shall be used. Auxiliary fan(s) may be used to maintain engine cooling during operation on the dynamometer. Rust inhibitors and lubrication additives may be used, up to the levels recommended by the additive manufacturer. Antifreeze mixtures and other coolants typical of those approved for use by the manufacturer may be used.

(f) *Exhaust system.* The exhaust system shall meet the following requirements:

(1) *Otto-cycle engines.* A chassis-type exhaust system shall be used. For all catalyst systems, the distance from the exhaust manifold flange(s) to the catalyst shall be the same as in the vehicle configuration unless the manufacturer provides data showing equivalent performance at another location. The catalyst container may be removed during all test sequences prior to the practice cycle, and replaced with an equivalent container having an inactive catalyst support.

(2) *Diesel engines.* Either a chassis-type or a facility-type exhaust system or both systems simultaneously may be used. If the engine is equipped with an exhaust aftertreatment device, the exhaust pipe must be the same diameter as found in-use for at least 4 pipe diameters upstream to the inlet of the beginning of the expansion section containing the aftertreatment device. The exhaust backpressure or restriction shall follow the same criteria as in § 86.1330-90 (f) and may be set with a valve (muffler omitted). The catalyst container may be removed during all test sequences prior to the practice cycle, and replaced with an equivalent container having an inactive catalyst support.

(i) The engine exhaust system shall meet the following requirements:

(A) The total length of the tubing from the exit of the engine exhaust manifold, turbocharger outlet or aftertreatment device to the primary dilution tunnel shall not exceed 32 feet (9.8 m).

(B) The initial portion of the exhaust system may consist of a typical in-use

(i.e., length, diameter, material, etc.) chassis-type exhaust system.

(C) The distance from the exhaust manifold flange(s) or turbocharger outlet to any exhaust aftertreatment device shall be the same as in the vehicle configuration or within the distance specifications provided by the manufacturer.

(D) For engines which are not equipped with exhaust aftertreatment devices, all tubing in excess of 12 feet (3.7 m) from the exit of the turbocharger or exhaust manifold shall be insulated. For engines equipped with exhaust aftertreatment devices, all tubing after the aftertreatment device which is in excess of 12 feet (3.7 m) shall be insulated.

(E) If the tubing is required to be insulated, the radial thickness of the insulation must be at least 1.0 inch (25 mm). The thermal conductivity of the insulating material must have a value no greater than 0.75 BTU-in/hr/ft²/°F (0.065 W/m-K) measured at 700 °F (371 °C).

(F) A smoke meter or other instrumentation may be inserted into the exhaust system tubing. If this option is exercised in the insulated portion of the tubing, then a minimal amount of tubing not to exceed 18 inches may be left uninsulated. However, no more than 12 feet (3.66 m) of tubing can be left uninsulated in total, including the length at the smoke meter.

(ii) The facility-type exhaust system shall meet the following requirements:

(A) It must be composed of smooth tubing made of typical in-use steel or stainless steel. This tubing shall have a maximum inside diameter of 6.0 in (15 cm).

(B) Short sections (altogether not to exceed 20 percent of the entire tube length) of flexible tubing at connection points are allowed.

[59 FR 48532, Sept. 21, 1994, as amended at 62 FR 47129, Sept. 5, 1997]

§ 86.1327-96 Engine dynamometer test procedures; overview.

(a) The engine dynamometer test procedure is designed to determine the brake specific emissions of hydrocarbons, nonmethane hydrocarbons, carbon monoxide, oxides of nitrogen,

particulate, methanol and formaldehyde, as applicable. The test procedure consists of a "cold" start test following either natural or forced cool-down periods described in §§ 86.1334 and 86.1335, respectively. A "hot" start test follows the "cold" start test after a hot soak of 20 minutes. The idle test of subpart P of this part may be run after the "hot" start test. The exhaust emissions are diluted with ambient air and a continuous proportional sample is collected for analysis during both the cold- and hot-start tests. The composite samples collected are analyzed either in bags or continuously for hydrocarbons (HC), methane (CH₄), carbon monoxide (CO), carbon dioxide (CO₂), and oxides of nitrogen (NO_x), or in sample collection impingers for methanol (CH₃OH) and sample collection impingers (or cartridges) for formaldehyde (HCHO), as applicable. Measurement of CH₃OH and HCHO may be omitted for 1990 through 1994 model year methanol-fueled engines when a FID calibrated on methanol is used. A bag or continuous sample of the dilution air is similarly analyzed for background levels of hydrocarbon, carbon monoxide, carbon dioxide, and oxides of nitrogen and, if appropriate, methane and/or methanol and/or formaldehyde. In addition, for diesel-cycle engines, particulates are collected on fluorocarbon-coated glass fiber filters or fluorocarbon-based (membrane) filters, and the dilution air may be prefiltered.

(b) Engine torque and rpm command set points shall be issued at 5 (10 Hz recommended) Hz or greater during both the cold and hot start tests. Feedback engine torque and rpm shall be recorded at least once every second during the test.

(c) Using the torque and rpm feedback signals, integrate the brake horsepower with respect to time for the cold and hot cycles. This produces a brake horsepower-hour value that enables the brake-specific emissions to be determined (see §§ 86.1342 and 86.1343).

(d)(1) When an engine is tested for exhaust emissions or is operated for service accumulation on an engine dynamometer, the complete engine shall be tested, with all emission control devices installed and functioning.

(2) For gasoline- and methanol-fueled engines, evaporative emission canisters must be loaded with fuel vapors and connected to the engine. The canisters used for testing must be of the same design as those used in engine applications.

(3) On air-cooled engines, the fan shall be installed.

(4) Additional accessories (e.g., oil cooler, alternators, air compressors, etc.) may be installed or their loading simulated if typical of the in-use application.

(5) The engine may be equipped with a production-type starter.

(e) Means of engine cooling that will maintain the engine operating temperatures (e.g., temperatures of intake air, oil, water, etc.) at approximately the same temperature as specified by the manufacturer shall be used. An auxiliary fan(s) may be used to maintain engine cooling during operation on the dynamometer. Rust inhibitors and lubrication additives may be used, up to the levels recommended by the additive manufacturer. Antifreeze mixtures and other coolants typical of those approved for use by the manufacturer may be used.

(f) *Exhaust system.* The exhaust system term shall meet the following requirements:

(1) *Gasoline-fueled and methanol-fueled Otto-cycle engines.* A chassis-type exhaust system shall be used. For all catalyst systems, the distance from the exhaust manifold flange(s) to the catalyst shall be the same as in the vehicle configuration unless the manufacturer provides data showing equivalent performance at another location. The catalyst container may be removed during all test sequences prior to the practice cycle, and replaced with an equivalent container having an inactive catalyst support.

(2) *Petroleum-fueled and methanol-fueled diesel engines.* Either a chassis-type or a facility-type exhaust system or both systems simultaneously may be used. If the engine is equipped with an exhaust aftertreatment device, the exhaust pipe must be the same diameter as found in-use for at least 4 pipe diameters upstream to the inlet of the beginning of the expansion section containing the aftertreatment device. The

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exhaust backpressure or restriction shall follow the same criteria as in § 86.1330-90(f) and may be set with a valve (muffler omitted). The catalyst container may be removed during all test sequences prior to the practice cycle, and replaced with an equivalent container having an inactive catalyst support.

(i) The engine exhaust systems shall meet the following requirements:

(A) The total length of the tubing from the exit of the engine exhaust manifold, turbocharger outlet or aftertreatment device to the primary dilution tunnel shall not exceed 32 feet (9.8 m).

(B) The initial portion of the exhaust system may consist of a typical in-use (i.e., length, diameter, material, etc.) chassis-type exhaust system.

(C) The distance from the exhaust manifold flange(s) or turbocharger outlet to any exhaust aftertreatment device shall be the same as in the vehicle configuration or within the distance specifications provided by the manufacturer.

(D) For engines which are not equipped with exhaust aftertreatment devices, all tubing in excess of 12 feet (3.7 m) from the exit of the turbocharger or exhaust manifold shall be insulated. For engines equipped with exhaust aftertreatment devices, all tubing after the aftertreatment device which is in excess of 12 feet (3.7 m) shall be insulated.

(E) If the tubing is required to be insulated, the radial thickness of the insulation must be at least 1.0 inch (25 mm). The thermal conductivity of the insulating material must have a value no greater than 0.75 BTU-in/hr/ft²/°F (0.065 W/m-K) measured at 700 °F (371 °C).

(F) A smoke meter or other instrumentation may be inserted into the exhaust system tubing. If this option is exercised in the insulated portion of the tubing, then a minimal amount of tubing not to exceed 18 inches may be left uninsulated. However, no more

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than 12 feet (3.66 m) of tubing can be left uninsulated in total, including the length at the smoke meter.

(ii) The facility-type exhaust system shall meet the following requirements:

(A) It must be composed of smooth tubing made of typical in-use steel or stainless steel. This tubing shall have a maximum inside diameter of 6.0 in (15 cm).

(B) Short sections (altogether not to exceed 20 percent of the entire tube length) of flexible tubing at connection points are allowed.

[58 FR 16064, Mar. 24, 1993, as amended at 59 FR 48533, Sept. 21, 1994; 60 FR 34374, June 30, 1995; 62 FR 47130, Sept. 5, 1997]

§ 86.1327-98 Engine dynamometer test procedures; overview.

Section 86.1327-98 includes text that specifies requirements that differ from § 86.1327-96. Where a paragraph in § 86.1327-96 is identical and applicable to § 86.1327-98, this may be indicated by specifying the corresponding paragraph and the statement “[Reserved]. For guidance see § 86.1327-96”.

(a) through (d)(3) [Reserved]. For guidance see § 86.1327-96.

(d)(4) Additional accessories (e.g., oil cooler, alternators, air compressors, etc.) may be installed or their loading simulated if typical of the in-use application. This loading shall be parasitic in nature and, if used, shall be applied during all engine testing operations, including mapping. The accessory work performed shall not be included in the integrated work used in emissions calculations.

(d)(5) through (f) [Reserved]. For guidance see § 86.1327-96.

[62 FR 47130, Sept. 5, 1997]

§ 86.1330-84 Test sequence; general requirements.

(a) The test sequence shown in Figure N84-10 shows the major steps of the test procedure.